

Type D Personality Predicts Poor Medication Adherence in Patients with Heart Failure in the USA

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Abstract

Background Type D (distressed) personality and medication nonadherence have been associated with poor health outcomes. Type D personality is associated with poor medication adherence in patients with coronary artery disease. However, the relationship between type D personality and medication adherence in patients with heart failure (HF) remains unknown.

Purpose Therefore, the goal of this study was to examine the association between type D personality and medication adherence in patients with HF.

Method This was a sub-analysis of baseline data from a randomized controlled trial with 84 patients with HF in the USA. Demographic, clinical, and psychological data were collected at baseline by interview, questionnaires, and medical record review. Type D personality was assessed using the Type D Personality Scale (DS14). Medication adherence was measured using both objective (Medication Event Monitoring System, MEMS) and self-reported (Morisky Medication Adherence Scale, MMAS-4) measures. Patients started medication adherence monitoring with the MEMS bottle at baseline and is used continuously for a month. Multiple regressions were used to explore the relationships between type D personality and medication adherence while adjusting for demographic, clinical, and psychological factors.

Results Patients with type D personality were more likely to have poor medication adherence. Type D personality was associated with medication adherence before and after

adjusting for covariates when it was analyzed as a categorical variable. However, type D personality was not associated with medication adherence when analyzed as a dimensional construct. Negative affectivity, a component of type D personality, was associated with medication adherence.

Conclusion As a dimensional construct, type D personality may not reflect the components of the personality associated with poor outcomes. Negative affectivity was associated with medication adherence in patients with HF. Interventions aiming to improving/enhancing medication adherence need to take into account patients with the negative affectivity component of type D personality who are at higher risk for poor medication adherence, which may lead to adverse health outcomes.

Keywords Type D personality · Medication adherence · Heart failure

Introduction

Many investigators have investigated the association of type D personality with clinical outcomes. Type D personality is a distressed personality that includes two stable personality traits: negative affectivity (NA) and social inhibition (SI) [1]. Individuals with a type D personality tend to experience increased negative emotions and tend not to share their emotions with others [1]. Previous research suggests that type D personality may be associated with poor health, including expressions of poor quality of life [2–4], greater number of cardiac symptoms and feelings of disability [5], major psychosocial stressors [6], impaired physical and mental health [3], morbidity [6–9], and even mortality [9–13] in the general population [14], and among patients with non-cardiovascular disease [15] and cardiovascular disease patients [7, 9, 11–13, 16, 17]. Some investigators, however,

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have failed to demonstrate a relationship between type D personality and mortality [18–21]. The null findings on mortality may be due to the low prevalence of type D personality [18, 19], high level of social support in the population [21], short follow-up periods [18, 19], differences in use of the construct as a categorical or dimensional variable [18], and cultural differences [20] in these studies.

Mols and Denollet [14] reviewed studies published from 2002 to 2009 concerning type D personality among the general population. The investigators concluded that type D personality was associated with symptoms of depression and anxiety, more somatic complaints and reports of poorer health, higher rates of absences, and more work-related stress [14]. In another recent review [15] of studies published from 2007 to 2009 on the implications of type D personality among non-cardiovascular patient populations, the investigators found that type D personality was associated with an increased severity of reported health complaints, heightened perception of negative emotions (depression and anxiety), poor adherence to treatment, and significantly reduced effort to perform during diagnostic testing, and had an adverse effect on health-related behaviors.

Type D personality may be a psychosocial risk factor for morbidity and mortality in patients with cardiovascular disease [16]. For example, Denollet and colleagues [8] followed 319 patients with coronary heart disease (CHD) for 5 years and found that type D personality measured at baseline was an independent predictor of future cardiac events. Patients with type D personality were 8.9 times more likely to experience a cardiac event compared to those without a type D personality [8]. In a prospective study, Martens and colleagues followed 473 patients hospitalized for acute myocardial infarction (MI) for 1.8 years and found that patients with type D personality had a twofold increased risk of total death/recurrent MI after adjusting for disease severity and depression and had a more than threefold increased risk of late death/recurrent MI [9]. In another prospective study, type D personality was a significant predictor of both cardiac and noncardiac death in 303 patients with CHD [17]. In the heart failure (HF) literature, patients with HF and type D personality were more likely to experience worse health-related quality of life [2–4], report more depressive symptoms [2], and have a higher incidence of cardiac mortality [10] compared with non-type D HF patients.

There is evidence for a number of potential biological mechanisms that could explain the relationship between type D personality and poor health outcomes in HF, such as higher level of proinflammatory cytokines (e.g., tumor necrosis factor- α) [22, 23], increased oxidative stress burden, and decreased antioxidant level [24]. There is also evidence for behavioral mechanisms linking type D personality with adverse outcomes, including self-management behaviors in patients with HF. For example, HF patients with type D personality were more likely to have inadequate consultation

seeking behavior even though they experienced more HF symptoms and appraised these symptoms as worrisome [25]. Failure to consult for HF symptoms increased risk of reporting impaired health status [26]. Moreover, type D personality was associated with nonadherence to respiratory treatment for patients with obstructive sleep apnea syndrome [27, 28].

Medication adherence is an essential self-management behavior in patients with chronic conditions [29]. To our knowledge, there are two recent studies in which the relationship between type D personality and medication adherence was examined [30, 31]. One study showed that type D personality as a dimensional construct was associated with poor medication adherence in patients with MI [31]. The other study demonstrated the same results in patients with acute coronary syndrome (ACS) when type D personality was measured as a categorical variable [30]. However, the relationship between type D personality and medication adherence in patients with HF remains unknown. HF is a chronic condition with high prevalence and incidence, and poor outcomes that requires patients to consistently take their prescribed medications to prevent emergency department visits, hospital admissions, or death [32–37]. Pharmacological treatment is vital for patients with HF to control symptoms and reduce hospitalizations and death [38, 39]. Therefore, medication adherence is essential to prevent morbidity and mortality in HF [40–42]. The purpose of this study was to determine the association between type D personality and medication adherence in patients with HF.

A recent taxometric analysis of the measure of type D personality has shown that type D personality may be better considered as a dimensional construct than a categorical construct [43]. There have been substantial concerns about the use of potentially artificial cut points to construct typology which may result in the likelihood of spurious results [44, 45]. There were two studies in which the impact of the dimensional construct of type D personality on medication adherence was examined with inconsistent findings [30, 31]. One study showed that type D personality predicted medication adherence [31]. In the other study, the investigator did not find a relationship between type D personality and medication adherence when type D personality was analyzed dimensionally (the interaction of NA and SI) [30]. Therefore, we aimed to determine whether type D personality was associated with medication adherence when analyzed as a dimensional construct in patients with HF.

Methods

Study Design

This was a sub-analysis of baseline data of a randomized control trial in patients with HF. Demographic, clinical, and

psychological data were collected by interview, questionnaires, and medical record review.

Sample and Setting

Detailed eligibility criteria and recruitment methods have been published previously [46]. Briefly, we recruited patients from the outpatient cardiology clinic and inpatient hospital in the Southern region of the USA. Patients with a confirmed diagnosis of chronic HF who were on stable doses of HF medications were enrolled in the study. Patients with obvious cognitive impairment (i.e., could not give informed consent or participate in an interview) and any coexisting terminal illness (e.g., end stage renal disease) were excluded.

Measurement of Variables

Type D Personality

Type D personality, negative affectivity, and social inhibition were assessed using the Type D Scale (DS-14) [47] at baseline, a 14-item questionnaire that included asking people if they would describe themselves with phrases such as, “I am a closed person” and “I often feel unhappy.” The items were answered on a five-point Likert scale from 0 (false) to 4 (true). Seven items refer to NA, and seven items refer to SI. The total scores for NA and SI subscales can range from 0 to 28 to assess personality traits. People who scored 10 points or more on both the NA and SI subscales were classified as type D personality. The DS-14 is a reliable and valid instrument that has been used to measure type D personality, NA, and SI in patients with hypertension [47], MI [31], and HF [3, 10, 24]. In this study, Cronbach's alpha was 0.86 and 0.82 for the NA and SI subscales, respectively.

Medication Adherence

As there is no “gold standard” measure for medication adherence, we used both self-reported (Morisky Medication Adherence Scale, MMAS-4) and objective (Medication Event Monitoring System, MEMS) measures to increase the accuracy of assessment. First, medication adherence was assessed using the MMAS-4 [48]. Patients were asked to answer four items [yes (score=1), no (score=0)], assessing how often over the last month medication was not taken for four reasons: forgetting to take it, being careless about taking it, not taking it because they felt better, and not taking it because they felt worse. The scores of the four items are summed for a total score that can range from 0 to 4; higher scores indicate poorer medication adherence. The MMAS-4 has demonstrated acceptable internal consistency (Cronbach's $\alpha=0.61$) and has been used to measure medication adherence in patients with hypertension [48] and HF [49].

Medication adherence was also measured objectively for 1 month (starting at baseline) using a microelectronic medication monitoring device (MEMS, AARDEX®-USA, Union City, CA) in the cap of a medication vial. Real-time data were recorded when the cap was removed. MEMS data were collected for one HF medication. Our previous studies demonstrate that monitoring of one medication is sufficient to capture overall medication adherence [50, 51]. The medication chosen for monitoring using the MEMS was selected in the following order: beta-adrenergic antagonist agent, angiotensin-converting-enzyme inhibitor, angiotensin receptor blocker, aldosterone antagonist, digoxin, or a diuretic. A MEMS diary was given to patients to record MEMS cap openings that were not related to taking medication such as refilling the bottle without taking medication. All cap openings unrelated to taking medications were deleted from the analysis. Medication adherence from the MEMS was defined as the dose-count, which is the percentage of prescribed doses taken during the monitoring period [42].

Other Variables of Interest

Age [52], gender [52, 53], ethnicity [26, 54], education level [33, 55, 56], left ventricular ejection fraction (a measure of ventricular function) [26, 57], comorbidity [58, 59], and perceived social support [26, 60, 61], which might influence medication adherence, were collected as covariates from the medical records or patient interview to adjust in the multiple regression. We also collected patients' marital status, body weight and height to calculate body mass index (BMI), New York Heart Association functional classification (NYHA), angiotensin-converting enzyme inhibitor use, and beta-antagonist use from patient interview and medication records to characterize patients by groups. Perceived social support was assessed using the Multidimensional Perceived Social Support Scale (MPSSS). The MPSSS is a reliable and valid instrument [62, 63]. Internal consistency of the MPSSS for this study was demonstrated by a Cronbach's alpha of 0.85. BMI was calculated as weight (in kilogram)/height (in square meter).

Procedure

The study was approved by the appropriate Institutional Review Boards. Patient eligibility was confirmed by a trained nurse who then explained study requirements to the patients and invited them to participate. At baseline, after obtaining an informed consent, the patient's demographic and clinical characteristics were collected by interview and medical record review, and patients completed the questionnaires (included DS-14 and MMAS-4). Detailed written and verbal instructions on use of the MEMS bottle were then given to

patients. Patients were instructed to take the specified medicine from the MEMS bottle continually for the monitoring period and to close the cap after each use. Patients who used a pill box were asked to keep the MEMS bottle next to their pill box and take that medicine from the MEMS bottle. An appointment was made 1 month later. At this visit, patients' MEMS data were downloaded to a personal computer and transferred into a database for analysis.

Data Analysis

All data analyses were performed using SPSS (Chicago, IL), version 18.0; an alpha level of <0.05 was used. Data analysis began with a descriptive examination of all variables, including frequency distributions, means, standard deviations, medians, and interquartile ranges, as appropriate to the level of measurement of the variables. We compared differences in demographic and clinical factors between groups using chi-square and t tests. Medication adherence was analyzed as a continuous variable. Nonparametric Spearman's rho was used to examine the correlation between medication adherence measured by the MMAS-4 and the MEMS. Multiple regression analyses were used to explore the relationship between type D personality and medication adherence while adjusting for demographic (age, gender, and ethnicity), clinical (LVEF and comorbidities), and psychological (perceived social support) factors.

As recommended by Ferguson and colleagues [43], to avoid using an artificial cut point and to use the full range of the data generated by the measures of type D personality, NA, SI, and type D personality were analyzed as continuous variables. In the multiple regression analysis, we entered continuous NA and SI measures and their interaction term (NA by SI) to determine the effect of type D personality when it is treated as a dimensional construct [30, 31].

We also conducted sensitivity analyses by reducing the number of covariates for which we adjusted (i.e., only included age, education level, comorbidities, and perceived social support) in the multiple regression models.

Results

Patient Characteristics

A total of 84 patients with HF were included in this study. The mean age of patients was 60 ± 13 years. About half of the patients were female. Half of patients were classified as NYHA class III or IV. Most patients had three other chronic comorbid conditions in addition to their HF. Full sample characteristics are presented in Table 1.

Type D Personality, Negative Affectivity, and Social Inhibition

The mean (SD) total score of the DS-14 was 16.2 (10.5). About one quarter (23.8 %) of the patients were identified as type D personality according to the cut point of 10 on both NA and SI subscales. Patients with type D personality were younger, had less education, and had more comorbidities compared to those without type D personality (Table 1).

The mean (SD) NA score was 7.7 (6.2), and the mean (SD) SI score was 8.4 (6.1). One third of the patients had the NA personality trait and about half (42.9 %) of the patients had the SI personality trait when the cut point 10 was used. Patients with NA personality were younger and had more comorbidities compared to those without this personality trait. No demographic and clinical characteristics differed between patients with and without the SI personality trait.

Medication Adherence and Type D Personality

More than half (52 %) of the patients in this study reported that they did not miss taking any of their medications. The mean medication adherence measure by the MEMS was 93.5 %. The correlation between medication adherence measured by the MMAS-4 and the MEMS was significant but weak ($\rho = 0.283$, $p = 0.01$). There was a gap between the results of self-reported adherence and adherence measuring using the MEMS: about half of participants (47 %) who self-reported that they did not miss taking any of their medications only took less than 80 % of their medications as assessed using the MEMS ($p = 0.009$).

MMAS-4 and Type D Personality

Type D personality when analyzed as a categorical variable was associated with medication adherence regardless of whether medication adherence was measured by the MMAS-4 or the MEMS. When medication adherence was assessed using the MMAS-4, patients with type D personality had poorer medication adherence compared with those without type D personality (1.05 vs. 0.56, $p = 0.027$). In multiple regression (Table 2), type D personality was associated with medication adherence before and after adjusting for demographic (age, gender, ethnicity, and education level), clinical (LVEF and comorbidities), and psychological (perceived social support) factors ($p = 0.027$ and 0.042, respectively). The model as a whole explained 19 % of the variance in medication adherence, with type D personality by itself explaining 5 % of variance.

In addition to type D personality, we also examined the effect of its components NA and SI on medication adherence. Only patients with NA had poorer medication adherence compared with those without NA (1.00 vs. 0.52, $p = 0.015$).

Table 1 Sample characteristics

Characteristics	Total sample (N=84)	Type D (n=20)	Non-type D (n=64)	p value
Age, years (mean $\pm$ SD)	60 $\pm$ 13	56 $\pm$ 13	61 $\pm$ 13	0.037
Female	37 (44 %)	10 (50 %)	27 (42 %)	0.610
Ethnicity				
Caucasian	65 (77 %)	12 (60 %)	53 (83 %)	0.062
Education, years (mean $\pm$ SD)	14.0 $\pm$ 3.6	12.5 $\pm$ 2.4	14.5 $\pm$ 3.8	0.008
Marital status				0.090
Married/cohabitate	49 (58 %)	9 (45 %)	40 (62.5 %)	
Single	13 (16 %)	7 (35 %)	6 (9.4 %)	
Divorced	17 (20 %)	3 (15 %)	14 (21.9 %)	
Widowed	5 (6 %)	1 (5 %)	4 (6.3 %)	
BMI (mean $\pm$ SD)	32.9 $\pm$ 8.8	34 $\pm$ 7.8	32.5 $\pm$ 9.2	0.508
LVEF (mean $\pm$ SD), %	38.0 $\pm$ 14.2	38.6 $\pm$ 16.5	37.8 $\pm$ 13.5	0.821
NYHA functional class				
III/IV	42 (50 %)	12 (60 %)	30 (47 %)	0.443
Charlson comorbidity index (mean $\pm$ SD)	3.1 $\pm$ 1.9	4 $\pm$ 2.3	2.8 $\pm$ 1.7	0.038
Perceived social support	67.9 $\pm$ 21.0	70.2 $\pm$ 23.2	67.2 $\pm$ 20.5	0.588
Taking ACEI	58 (70 %)	16 (80 %)	42 (67 %)	0.402
Taking BB	80 (95 %)	20 (100 %)	60 (94 %)	0.568
Medication adherence (mean $\pm$ SD) as measured by the MMSA-4	0.68 $\pm$ 0.87	1.05 $\pm$ 1.05	0.56 $\pm$ 0.77	0.027
Medication adherence (mean $\pm$ SD) as measured by the MEMS	93.5 $\pm$ 10.8	88.9 $\pm$ 17.6	95.0 $\pm$ 7.4	0.03

BMI body mass index, LVEF left ventricular ejection fraction, NYHA New York Heart Association, ACEI angiotensin-converting-enzyme inhibitor, BB beta-blocker, MMAS-4 Morisky Medication Adherence Scale, MEMS Medication Event Monitoring System

In the regression models, NA was associated with medication adherence before and after adjusting for demographic, clinical, and psychological factors ($p=0.044$ and 0.016 , respectively). SI personality trait was not associated with medication adherence.

When type D personality, NA, and SI were analyzed as continuous variables, we had similar results. Type D personality was associated with medication adherence before

and after adjusting for the same covariates ($p=0.011$ and 0.033 , respectively) when measured by the MMAS-4. Likewise, when NA and SI were entered as continuous variables in the model, only NA was associated with medication adherence ($p=0.026$). However, when NA, SI, and their interaction term were entered in the multiple regression, none of them were associated with medication adherence (Table 3).

Table 2 The association of type D personality and medication adherence (N=84)

Variables	Beta	95 % CI	p value	Total R ²
Unadjusted model*				
Type D personality	−0.241	−0.919 to −0.056	0.027	
Adjusted model**				
Step 1				10 %
Age	−0.169	−0.026 to 0.003	0.125	
Gender	0.228	0.008 to 0.788	0.046	
Ethnicity	0.046	−0.364 to 0.552	0.684	
Education	−0.042	−0.063 to 0.043	0.707	
Step 2				14 %
Left ventricular ejection fraction	0.009	−0.013 to 0.014	0.939	
Comorbidity	−0.086	−0.143 to 0.065	0.459	
Perceived social support	−0.196	−0.017 to 0.001	0.077	
Step 3				19 %
Type D personality	−0.239	−0.949 to −0.017	0.042	

As measured by the Morisky Medication Adherence Scale-4

* $F=5.059$, $p=0.027$; ** $F=2.179$, $p=0.039$ (adjusting for age, gender, ethnicity, education, left ventricular ejection fraction, comorbidity, and perceived social support)

Table 3 Negative affectivity, social inhibition, and medication adherence ($N=84$)

Variables	Beta	95 % CI	<i>p</i> value
Step 1			
Age	−0.169	−0.026 to 0.003	0.125
Gender	0.228	0.008 to 0.788	0.046
Ethnicity	0.046	−0.364 to 0.552	0.684
Education	−0.042	−0.063 to 0.043	0.707
Step 2			
Left ventricular ejection fraction	0.009	−0.013 to 0.014	0.939
Comorbidity	−0.086	−0.143 to 0.065	0.459
Perceived social support	−0.196	−0.017 to 0.001	0.077
Step 3			
Negative affectivity	0.289	0.005 to 0.076	0.026
Social inhibition	0.008	−0.033 to 0.036	0.949
Step 4			
Negative affectivity	0.271	−0.020 to 0.096	0.196
Social inhibition	−0.008	−0.053 to 0.051	0.967
Negative affectivity × social inhibition	0.032	−0.004 to 0.005	0.911

As measured by the Morisky Medication Adherence Scale-4

MEMS and Type D Personality

When medication adherence was assessed using the MEMS, patients with type D personality had poorer medication adherence compared with those without type D personality (88.9 vs. 95.0, $p=0.03$). In multiple regression (Table 4), type D personality was associated with medication adherence when measured by the MEMS before and after adjusting for same demographic, clinical, and psychological factors ($p=0.03$ and 0.043, respectively). The model explained 13 % of the variance in medication adherence, with type D personality by itself explaining 5 % of variance.

When the components of type D personality, NA, and SI were used in the model, only patients with NA had poorer

medication adherence compared with those without NA (95 vs. 90, $p=0.042$). In the regression models, NA personality trait ($p=0.042$), but not SI ($p=0.098$) was associated with medication adherence.

When type D personality, NA, and SI were analyzed as continuous variables, type D personality was associated with medication adherence before ($p=0.049$), but not after ($p=0.121$) adjusting for the same covariates. When NA and SI were entered as continuous variables in the model, only NA was associated with medication adherence ($p=0.038$). When type D personality was analyzed as a dimensional construct, the associations between NA, SI, their interaction term, and medication adherence revealed no significant results (Table 5).

Table 4 The association of type D personality and medication adherence ($N=84$)

Variables	Beta	95 % CI	<i>p</i> value	Total R^2
Unadjusted model*				
Type D personality	0.239	0.598 to 11.638	0.03	
Adjusted model				
Step 1				6 %
Age	0.221	−0.003 to 0.394	0.054	
Gender	−0.010	−5.368 to 4.911	0.930	
Ethnicity	0.008	−5.766 to 6.180	0.945	
Education	0.077	−0.465 to 0.932	0.507	
Step 2				8 %
Left ventricular ejection fraction	−0.076	−0.239 to 0.123	0.524	
Comorbidity	0.088	−0.908 to 1.931	0.475	
Perceived social support	0.114	−0.059 to 0.175	0.326	
Step 3				13 %
Type D personality	0.247	0.206 to 12.397	0.043	

As measured by the Medication Event Monitoring System

* $F=4.865$, $p=0.03$; ** $F=1.329$, $p=0.243$ (adjusting for age, gender, ethnicity, education, left ventricular ejection fraction, comorbidity, and perceived social support)

Table 5 Negative affectivity, social inhibition, and medication adherence ($N=84$)

Variables	Beta	95 % CI	<i>p</i> value
Step 1			
Negative affectivity	−0.254	−0.857 to −0.026	0.038
Social inhibition	−0.003	−0.429 to 0.418	0.980
Step 2			
Negative affectivity	−0.274	−0.171 to 0.218	0.176
Social inhibition	−0.022	−0.708 to 0.632	0.910
Negative affectivity × social inhibition	0.035	−0.052 to 0.059	0.900

As measured by the Medication Event Monitoring System

Sensitivity Analysis

When we reduced the number of covariates to include only age, education level, comorbidities, and perceived social support in the multiple regression models, we found similar results. When type D personality was analyzed as a categorical variable, type D was associated with medication adherence no matter medication adherence was assessed using the MMAS-4 ($p=0.032$) or the MEMS ($p=0.040$) after adjusting for covariates. When type D personality was analyzed as a continuous variable, type D was associated with medication adherence when it was assessed using the MMAS-4 ($p=0.034$), but not using the MEMS ($p=0.117$) after adjusting for covariates. Likewise, when type D personality was analyzed as a dimensional construct, NA, SI, and their interaction term were not associated with medication adherence no matter medication adherence was assessed using the MMAS-4 or the MEMS after adjusting for covariates.

Discussion

In this study, we explored the association between type D personality and medication adherence in patients with HF. To our knowledge, this is the first study to examine the relationship between type D personality and medication adherence in this patient population. However, we had two conflicting findings. We found that type D personality was associated with medication adherence when type D personality was analyzed as a categorical variable using both objective and self-reported measures of adherence before and after adjusting for demographic, clinical, and psychosocial variables, but when analyzed as a dimensional construct, type D personality was not associated with medication adherence.

Our findings that type D personality was associated with medication adherence when type D personality was analyzed as a categorical variable are consistent with previous research on the adverse effects of type D personality on self-management behaviors. It is worthy to note that most research studied the relationship between type D personality and self-management behaviors analyzed type D personality as a categorical variable [25, 27, 28]. Schiffer and colleagues

[25] examined whether type D personality predicted poor self-management and failure to consult for cardiac symptoms in 178 outpatients with HF and found that HF patients with type D personality experienced more HF symptoms (i.e., shortness of breath, fatigue, and sleep problems, odd ratio (OR)=6.4). However, they were less likely to report these symptoms to their health care providers and had an increased risk for inadequate consultation behavior (OR=2.7). In another study, HF patients with type D personality who displayed inadequate consultation behavior were at a sixfold increased risk of reporting impaired health status, compared to those without type D personality who displayed adequate consultation behavior [64]. Moreover, Brostrom and associates examined the relationship between type D personality and continuous positive airway pressure (CPAP) adherence in 247 outpatients with obstructive sleep apnea syndrome and found that CPAP adherence was significantly lower for patients with type D personality [27]. Likewise, Dieltjens and colleagues [28] found that the odds ratio for nonadherence to mandibular advancement device, an alternative treatment for patients with sleep apnea, was 6.03 for type D personality adjusted for covariates. These findings suggest that patients with type D personality had more difficulties following self-management behaviors.

Adherence to prescribed medication is critical for patients with HF to have better health outcomes [40–42]. Previous studies have shown that some biological factors (e.g., cytokines [22, 23] and antioxidant level [24]) may explain the relationship between type D personality and cardiac events. However, the underlying linkages for the type D personality and poor outcomes are largely unknown. Our findings of this study when type D personality was analyzed as a categorical variable suggest another possible behavioral link between type D personality and adverse health outcomes—that is, poor adherence to prescribed medication.

However, type D personality was not associated with medication adherence when analyzed as a dimensional construct. Our study needs to be considered in light of the findings from similar studies. To date, there have been two investigations examining the relationship between the dimensional construct of type D personality and medication adherence [30, 31]. Our findings were consistent with one

study which showed that dimensional type D personality was not independently associated with medication adherence in patients with ACS [30]. However, the other study did show that type D personality as measured as a dimensional construct predicted medication adherence in patients with MI [31]. We do not know why type D personality was associated with medication adherence when type D personality was analyzed as a continuous variable, categorically, but not dimensionally (continuous NA and SI measures and their interaction term). Some researchers had considerable concerns regarding approaches to conceptualization of type D personality, namely a dimensional or categorical construct [43, 65]. There also have been a number of null findings published recently between type D personality and outcomes or self-care behaviors [18–21, 30, 65]. Our findings—in conjunction with prior researchers'—suggest there may not be a robust relationship between type D personality and medication adherence. Additional research is needed to prospectively examine and verify the relationship between the dimensional construct of type D personality on medication adherence in patients with HF.

In line with the earlier study [30], our data showed the NA personality trait analyzed as either dichotomized or continuous variable was independently associated with medication adherence using both objective and self-reported measures of medication adherence, suggesting the primacy of NA over the type D personality in association with medication adherence.

It is interesting to note that the correlation between objective adherence and self-reported measure was significant but weak: high mean objective adherence (93.5 %); but only 52 % of the participants self-reported that they did not miss taking any of their medications. We previously reported that there was a gap between the results of self-reported adherence and adherence measuring using the MEMS [42]. In the current study, we found that about half of participants that self-reported that they did not miss taking any of their medications only took less than 80 % of their medications as assessed using the MEMS. Though self-reported medication adherence is feasible and may provide a gross indicator of adherence [48], it should be interpreted with caution in clinical settings and future studies.

In a recent review, the prevalence of type D personality ranged from 27 to 31 % in patients with cardiovascular disease [15]. The prevalence of type D personality ranged from 18.2 to 32 % in patients with HF [3, 4, 24, 64]. In our study, the prevalence of type D personality in patients with HF was 23.8 %. Therefore, our finding is consistent with the current HF literature.

The results of this study are limited by the small sample size and, therefore, we only can adjust some potential confounders that might have an impact on medication adherence in the multiple regression models. In our sensitivity

analyses, we reduced the covariates to four variables in the multiple regression models and had similar results. However, future studies of this phenomenon should include a larger sample so that the complex dynamics surrounding type D personality and medication adherence can be better illuminated. The relatively small effect size also may produce unstable results especially in multiple regression models that need to be verified in a larger sample. Thus, our findings should be considered exploratory and the need for replication emphasized. Also, this was a sub-analysis of baseline data of an intervention study in patients with HF. To compare participants' objective medication adherence before and after intervention and also to sustain the participants in the study in this fragile patient population, medication adherence before the intervention was measured by the MEMS for 1 month. The 1-month monitoring period might be a little short to reflect participants' medication adherence. The strength of this study is that it is the first study to examine the relationship between type D personality and medication adherence in patients with HF by using both self-reported and an objective measures to assess medication adherence.

Conclusion

Type D personality was associated with medication adherence when it was analyzed as a categorical variable, but not associated with medication adherence when analyzed as a dimensional construct. Negative affectivity was associated with medication adherence in patients with HF. Thus, screening for type D personality, especially for the NA personality trait in patients with HF may help to identify those who are at higher risk of poor medication adherence. Interventions aiming to improving/enhancing medication adherence need to take into account patients with negative affectivity personality who are at higher risk for medication nonadherence, which may lead to adverse health outcomes.

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References

- Denollet J. Type D personality. A potential risk factor refined. *J Psychosom Res.* 2000;49(4):255–66.
- Schiffer AA et al. The distressed (type D) personality is independently associated with impaired health status and increased depressive symptoms in chronic heart failure. *Eur J Cardiovasc Prev Rehabil.* 2005;12(4):341–6.
- Schiffer AA et al. Type D personality and depressive symptoms are independent predictors of impaired health status in chronic heart failure. *Eur J Heart Fail.* 2008;10(9):922–30.
- Pedersen SS et al. Type D personality is a predictor of poor emotional quality of life in primary care heart failure patients independent of depressive symptoms and New York Heart Association functional class. *J Behav Med.* 2010;33(1):72–80.
- Pelle AJ et al. Beyond type D personality: reduced positive affect (anhedonia) predicts impaired health status in chronic heart failure. *Qual Life Res.* 2009;18(6):689–98.
- Michal M et al. Type D personality is independently associated with major psychosocial stressors and increased health care utilization in the general population. *J Affect Disord.* 2011;134(1–3):396–403.
- Denollet J, Brutsaert DL. Personality, disease severity, and the risk of long-term cardiac events in patients with a decreased ejection fraction after myocardial infarction. *Circulation.* 1998;97(2):167–73.
- Denollet J, Vaes J, Brutsaert DL. Inadequate response to treatment in coronary heart disease : adverse effects of type D personality and younger age on 5-year prognosis and quality of life. *Circulation.* 2000;102(6):630–5.
- Martens EJ et al. Type D personality predicts clinical events after myocardial infarction, above and beyond disease severity and depression. *J Clin Psychiatry.* 2010;71(6):778–83.
- Schiffer AA et al. Type D personality and cardiac mortality in patients with chronic heart failure. *Int J Cardiol.* 2010;142(3):230–5.
- Pedersen SS et al. Pre-implantation implantable cardioverter defibrillator concerns and type D personality increase the risk of mortality in patients with an implantable cardioverter defibrillator. *Europace.* 2010;12(10):1446–52.
- Aquarius AE et al. Type D personality and mortality in peripheral arterial disease: a pilot study. *Arch Surg.* 2009;144(8):728–33.
- Denollet J, Sys SU, Brutsaert DL. Personality and mortality after myocardial infarction. *Psychosom Med.* 1995;57(6):582–91.
- Mols F, Denollet J. Type D personality in the general population: a systematic review of health status, mechanisms of disease, and work-related problems. *Health Qual Life Outcomes.* 2010;8:9.
- Mols F, Denollet J. Type D personality among noncardiovascular patient populations: a systematic review. *Gen Hosp Psychiatry.* 2010;32(1):66–72.
- Kupper N, Denollet J. Type D personality as a prognostic factor in heart disease: assessment and mediating mechanisms. *J Pers Assess.* 2007;89(3):265–76.
- Denollet J et al. Personality as independent predictor of long-term mortality in patients with coronary heart disease. *Lancet.* 1996;347(8999):417–21.
- Coyne JC et al. Lack of prognostic value of type D personality for mortality in a large sample of heart failure patients. *Psychosom Med.* 2011;73(7):557–62.
- Pelle AJ et al. Psychological distress and mortality in systolic heart failure. *Circ Heart Fail.* 2010;3(2):261–7.
- Grande G et al. Type D personality and all-cause mortality in cardiac patients—data from a German cohort study. *Psychosom Med.* 2011;73(7):548–56.
- Volz A et al. Predictors of readmission and health related quality of life in patients with chronic heart failure: a comparison of different psychosocial aspects. *J Behav Med.* 2011;34(1):13–22.
- Denollet J et al. Cytokines and immune activation in systolic heart failure: the role of type D personality. *Brain Behav Immun.* 2003;17(4):304–9.
- Denollet J, Vrints CJ, Conraads VM. Comparing type D personality and older age as correlates of tumor necrosis factor- α dysregulation in chronic heart failure. *Brain Behav Immun.* 2008;22(5):736–43.
- Kupper N et al. Association between type D personality, depression, and oxidative stress in patients with chronic heart failure. *Psychosom Med.* 2009;71(9):973–80.
- Schiffer AA et al. Failure to consult for symptoms of heart failure in patients with a type-D personality. *Heart.* 2007;93(7):814–8.
- Wu JR et al. Predictors of medication adherence using a multidimensional adherence model in patients with heart failure. *J Card Fail.* 2008;14(7):603–14.
- Brostrom A et al. Association of type D personality to perceived side effects and adherence in CPAP-treated patients with OSAS. *J Sleep Res.* 2007;16(4):439–47.
- Dieltsjens M et al. Impact of type D personality on adherence to oral appliance therapy for sleep-disordered breathing. *Sleep Breath.* 2013;17(3):985–91.
- Sabate E. Adherence to long-term therapies: evidence for action. Geneva: World Health Organization; 2003.
- Molloy GJ et al. Type D personality, self-efficacy, and medication adherence following an acute coronary syndrome. *Psychosom Med.* 2012;74(1):100–6.
- Williams L et al. Type D personality predicts poor medication adherence in myocardial infarction patients. *Psychol Health.* 2011;26(6):703–12.
- Chin MH, Goldman L. Factors contributing to the hospitalization of patients with congestive heart failure. *Am J Public Health.* 1997;87(4):643–8.
- Chui MA et al. Association between adherence to diuretic therapy and health care utilization in patients with heart failure. *Pharmacotherapy.* 2003;23(3):326–32.
- Happ MB, Naylor MD, Roe-Prior P. Factors contributing to rehospitalization of elderly patients with heart failure. *J Cardiovasc Nurs.* 1997;11(4):75–84.
- Joshi PP et al. Factors precipitating congestive heart failure—role of patient non-compliance. *J Assoc Physicians India.* 1999;47(3):294–5.
- Li H, Morrow-Howell N, Proctor EK. Post-acute home care and hospital readmission of elderly patients with congestive heart failure. *Health Soc Work.* 2004;29(4):275–85.
- Miura T et al. Effect of digoxin noncompliance on hospitalization and mortality in patients with heart failure in long-term therapy: a prospective cohort study. *Eur J Clin Pharmacol.* 2001;57(1):77–83.
- Stanley M, Prasun M. Heart failure in older adults: keys to successful management. *AACN Clin Issues.* 2002;13(1):94–102.
- Sadik A, Yousif M, McElnay JC. Pharmaceutical care of patients with heart failure. *Br J Clin Pharmacol.* 2005;60(2):183–93.
- De Geest S, Sabate E. Adherence to long-term therapies: evidence for action. *Eur J Cardiovasc Nurs.* 2003;2(4):323.
- Hope CJ et al. Association of medication adherence, knowledge, and skills with emergency department visits by adults 50 years or older with congestive heart failure. *Am J Health Syst Pharm.* 2004;61(19):2043–9.
- Wu JR et al. Objectively measured, but not self-reported, medication adherence independently predicts event-free survival in patients with heart failure. *J Card Fail.* 2008;14(3):203–10.
- Ferguson E et al. A taxometric analysis of type-D personality. *Psychosom Med.* 2009;71(9):981–6.
- de Voogd JN et al. More evidence that depressive symptoms predict mortality in COPD patients: is type D personality an alternative explanation? *Ann Behav Med.* 2009;38(2):86–93.

45. Suls J, Bunde J. Anger, anxiety, and depression as risk factors for cardiovascular disease: the problems and implications of overlapping affective dispositions. *Psychol Bull.* 2005;131(2):260–300.
46. Wu JR et al. Effect of a medication-taking behavior feedback theory-based intervention on outcomes in patients with heart failure. *J Card Fail.* 2012;18(1):1–9.
47. Denollet J. DS14: standard assessment of negative affectivity, social inhibition, and type D personality. *Psychosom Med.* 2005;67(1):89–97.
48. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care.* 1986;24(1):67–74.
49. Farrell K et al. Utility of the Millon Behavioral Medicine Diagnostic to predict medication adherence in patients diagnosed with heart failure. *J Clin Psychol Med Settings.* 2011;18(1):1–12.
50. Bouvy ML et al. Effect of a pharmacist-led intervention on diuretic compliance in heart failure patients: a randomized controlled study. *J Card Fail.* 2003;9(5):404–11.
51. Dunbar-Jacob J et al. Medication adherence in persons with cardiovascular disease. *J Cardiovasc Nurs.* 2003;18(3):209–18.
52. Monane M et al. Noncompliance with congestive heart failure therapy in the elderly. *Arch Intern Med.* 1994;154(4):433–7.
53. Roe CM et al. Angiotensin-converting enzyme inhibitor compliance and dosing among patients with heart failure. *Am Heart J.* 1999;138(5 Pt 1):818–25.
54. Gellad WF, Haas JS, Safran DG. Race/ethnicity and nonadherence to prescription medications among seniors: results of a national study. *J Gen Intern Med.* 2007;22(11):1572–8.
55. Evangelista LS, Berg J, Dracup K. Relationship between psychosocial variables and compliance in patients with heart failure. *Heart Lung.* 2001;30(4):294–301.
56. Wu JR et al. Medication adherence in patients who have heart failure: a review of the literature. *Nurs Clin North Am.* 2008;43(1):133–53.
57. Greenberg BH et al. COMPARE: comparison of the effects of carvedilol CR and carvedilol IR on left ventricular ejection fraction in patients with heart failure. *Am J Cardiol.* 2006;98(7A):53L–9.
58. McLane CG, Zyzanski SJ, Flocke SA. Factors associated with medication noncompliance in rural elderly hypertensive patients. *Am J Hypertens.* 1995;8(2):206–9.
59. Balkrishnan R et al. Predictors of medication adherence and associated health care costs in an older population with type 2 diabetes mellitus: a longitudinal cohort study. *Clin Ther.* 2003;25(11):2958–71.
60. Bontempi JM, Burleson L, Lopez MH. HIV medication adherence programs: the importance of social support. *J Community Health Nurs.* 2004;21(2):111–22.
61. DiMatteo MR. Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. *Med Care.* 2004;42(3):200–9.
62. Canty-Mitchell J, Zimet GD. Psychometric properties of the multidimensional scale of perceived social support in urban adolescents. *Am J Community Psychol.* 2000;28(3):391–400.
63. Picardi A et al. Stress, social support, emotional regulation, and exacerbation of diffuse plaque psoriasis. *Psychosomatics.* 2005;46(6):556–64.
64. Pelle AJ et al. Inadequate consultation behavior modulates the relationship between type D personality and impaired health status in chronic heart failure. *Int J Cardiol.* 2010;142(1):65–71.
65. Smith TW. Toward a more systematic, cumulative, and applicable science of personality and health: lessons from type D personality. *Psychosom Med.* 2011;73(7):528–32.